DOES SINGING PROVIDE HEALTH BENEFITS?

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ABSTRACT

Background: Amateur choir singing is a common recreational and communal activity in adulthood. Previous research suggests a variety of psychological and physiological effects of choir singing. In particular, significant changes of emotional state as well as increases of specific immune functions have been observed.

Aims: The main purpose of this study was to assess the emotional and neurohumoral effects of choir singing. The research questions addressed the extent of emotional and endocrine responses to singing or listening to choir music.

Method: Thirty-one participants (23 female, 29 to 74 years of age) were subjected to two conditions, namely singing versus listening (pre-post-design). Measures of emotional effect as well as samples of saliva, for the assessment of secretory immunoglobulin A (sIgA) and cortisol, were taken from each individual.

Results: Significant changes in both subjective and physiological measures were observed. With respect to active singing, there were significant increases in positive and decreases in negative emotional state. SigA significantly increased, whereas mean cortisol values were not affected by singing. Increases of negative emotional state were found in the passive listening condition. Significant decreases of cortisol were found also in this condition, while mean levels of sIgA were unchanged.

Conclusions: These results suggest differentiated neurohumoral responses to choir singing. Taken together, these preliminary results confirm and extent previous findings of positive emotional and immunogenetic effects of group singing.

1. INTRODUCTION

The purpose of the present study is to assess neurohumoral and emotional effects of group singing in a non-professional chorale. Previous research has indicated that choir singers perceive specific health benefits and experience changes of mood [5,18]. Some of the psychophysiological effects have been investigated using a variety of measures, e.g. electrocardiography [19], serum concentrations of cortisol, TNF alpha, prolactin, oxytocin and other biochemical markers [9], and secretory immunoglobulin A (sIgA) and cortisol in saliva samples [2]. In particular, Beck et al. [2] found that sIgA concentrations increased significantly in members from a professional choir during two rehearsals and a performance of Beethoven's *missa solemnis*. Cortisol levels dropped during rehearsals, but increased during performance, perhaps as a result of stage fright [21]. Moreover, it was found that subjective measures of emotional involvement in singing predicted sIgA changes in the concert condition, but not in the rehearsal conditions.

It should be noted that none of these studies was able to relate the observed effects directly to singing as a specific musical, or physically demanding activity. Thus, immunogenetic effects are to date difficult to interpret as a result of singing. For example, studies on the perception of music suggest, that listening in itself may induce a range of psychophysiological changes (see [1], for a review; [3,7,8,11,14,15,17]). Moreover, although no physiological measures were involved in their study, Unwin, Kenny & Davis [18] were unable to statistically distinguish between singers and non-singers in terms of changes in subjective measures of emotional affect. Positive mood changes were found in various subscales of the P.O.M.S (Profile of mood states) questionnaire in both groups after singing or listening to choral music only.

We hypothesized that singing enhances specific immune functions as well as it leads to positive changes of emotional affect in amateur singers. With respect to neuroendocrine effects of music processing, in general, and to Beck et al.'s [2] findings indicating immunogenetic effects of choir singing, in particular, we sought to extend this research. In the present study, we adapted a similar naturalistic experimental setting. Changes of secretory immunoglobulin A (sIgA) and cortisol in indivirual singers were determined by analyzing saliva samples before and after singing. However, three important methodological differences should be noted. Instead of a professional chorale, amateur singers participated in the present study. Second, time intervals between pre- and post-measurements were kept constant (60 minutes for each condition). Third, and most importantly, a *listening only* condition was introduced to compare the relative effects between the two musical activities.

Emotional state was measured before and after each condition by using a standard psychometric scale. A final goal of the study was to determine correlations between physiological and subjective measures. However, in lieu of extensive research on the psychophysiology of emotion, such correlations are usually weak [4,13], and apparently mediated by biographic factors, which are beyond the scope of the present study.

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2. METHOD

2.1. Participants

Thirty-one members (23 female) of an amateur choir participated in this study. Individual age ranged from 29 to 74 years (mean age = 56.9 years, standard deviation = 14.8 years). None of the participants reported extensive smoking, drinking or serious health problems.

2.2. Design and procedure

The two experimental conditions for this study were realized in two sessions at the same location in the rehearsal room of a church and at the regular time of that choirs' rehearsal between 6 and 7 p.m. Participants were instructed not to take in any meals, or alcoholic drinks, and refrain from smoking within one hour before the start of the rehearsal. The sessions were conducted a week apart and lasted 60 minutes each. Before the first session started, each participant filled out a demographic questionnaire. Moreover, before each of the two sessions, a psychometric scale for the measurement of emotional state (Positive and Negative Affect Schedule, PANAS, [12,20]) was completed. The PANAS was filled out once again at the end of each session. Also, at the beginning and at the end of each session, saliva was collected using a standard procedure (see next section). Measured proteins in saliva samples were immonuglobulin A, albumin, and cortisol. Albumin levels served as an exclusion criterion for blood contaminated saliva samples.

Singing condition. The singing condition was initiated by a ten-minute warm-up phase, in which various breathing, stretching, and vocalization exercises were performed. For the rest of the session, sections and pieces from Mozarts *Requiem* were rehearsed, and instructions by the conductor given to the choir. The participants stood up only during the warm-up, whereas they remained seated for the rest of the time. Times of interruptions by the conductor were measured and approximated ten minutes of the rehearsal time.

Listening condition. During the second session one week later, the pieces from Mozarts *Requiem* were presented from CD, and articles on singing from an eighteenth century encyclopedia of the arts (Sulzer, 1967) were read aloud. Participants were seated during the entire session. Importantly, when music was played they were instructed to listen to the music attentively.

Saliva collection. Saliva has been collected with Sarstedt Salivettes®. This device consists of a plastic tube containing a cotton wool swab. Subjects were asked to insert the swab into their mouth and were instructed not to swallow saliva for the period of exactly 5 minutes. Afterwards this cotton wool swab was given back into the tube. Saliva samples were centrifuged at 4000 x g for 10 minutes and then were kept at -30/C until assayed.

Assaying of sIgA and albumin. After thawing saliva was analyzed for concentrations of sIgA and albumin by use of a fully automated nephometric analyses (BN100, Dade Behring, Marburg, FRG). The assay protocol has been adapted to the expected range for saliva concentrations of sIgA between 0 - 120 mg/dl and albumin (0 - 27 mg/dl), respectively using highly specific monoclonal antibodies for human sIgA and albumin (Dade Behring). Previous measures revealed extremely high intra- and interassay precision which can be expected in general for protein analysis and which justifies single measurements of samples in clinical practice. IgA secretion has been shown in methodological studies to depend on the saliva flow rate [16]. Therefore, albumin concentration was used as an index of the saliva flow rate. Secretory IgA was determined as the ratio of IgA concentration and albumin.

Assaying of saliva cortisol. Saliva cortisol was determined using a commerical lumineszens-immuno assay (IBL, Hamburg, FRG) especially designed for saliva samples and approved by the Food and Drug Administration (FDA). Pipetting of standards, samples and reagents was performed by a fully automated system (Labotech, Freiburg, FRG). Lumnineszens units were read by use of an automatic luminometer (Beckmann, FRG). All samples were measured in duplicates with sufficient intra-assay precision (coefficient of variance, CV < 6%). They were analyzed with assays obtained from the same charge to reduce interassay variation, which was lower than 10%.

3. RESULTS

3.1. Physiological measures

Table 1 presents mean baseline values of secretory Immunoglobulin A (sIgA) and cortisol for the two experimental conditions. Comparison of means between the conditions revealed no significant differences for each measure (sIgA: t (30) = .95; p = .35; cortisol: t (30) = .45; p = .66).

Condition	SIgA	Cortisol [ng/ml]
Singing	3.66 (3.15)	0.75 (0.67)
Listening	4.10 (4.20)	0.81 (0.61)

Table 1. Means (and standard deviations) of sIgA and cortisol baseline values in the two experimental conditions.
Note: sIgA values are expressed as the ratio of IgA [mg/dl] / albumin [mg/dl].

Differences in sIgA and cortisol levels between pre- and post-measurements were calculated for the two conditions (see Table 2). A comparison of mean changes for sIgA using a paired t-Test revealed a significant difference between conditions, t (30) = 2.08; p < .05. Mean changes in sIgA levels were positive in both conditions, but only changes in the singing condition reached statistical significance, t (30) = 3.37; p < .005, whereas mean changes were not significant in the listening condition, t (30) = 1.05; p = .30. By contrast, cortisol levels significantly decreased during listening, t (30) = 3.48; p < .02. Cortisol decreases after singing were not significant, t (30) = 1.60; p = .12.

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Condition	sIgA	Cortisol [ng/ml]
Singing	1.62 (2.68)	-0.16 (0.56)
Listening	0.39 (2.07)	-0.36 (0.56)

Table 2. Means (and standard deviations) of changes of sIgA and cortisol of sIgA and cortisol values in the two experimental conditions.
Note: sIgA values are expressed as the ratio of IgA [mg/dl] / albumin [mg/dl].

3.2. Psychological measures

Baseline values for positive and negative affect scales from the PANAS are represented in Table 3. Data from three subjects could not be analyzed due to a large proportion of missing values. Comparisons of means between the two conditions were not significant (positive affect: $t(27) = .07$; $p = .95$; negative affect: $t(27) = 1.18$; $p = .25$).

Condition	Positive Affect	Negative Affect
Singing	2.86 (0.51)	1.31 (0.4)
Listening	2.85 (0.67)	1.23 (0.25)

Table 3. Means (and standard deviations) of Positive and Negative Affect score baseline values in the two experimental conditions.
Note: Scores of each scale were divided by the number of items.

Table 4 presents changes of mean scores for positive and negative mood with respect to condition. Positive mood changes increased significantly only in the singing condition, $t(27) = 2.34$; $p < .03$, but not in the listening condition, $t(27) = .54$; $p = .59$. By contrast, negative mood significantly increased in the listening condition, $t(27) = 14.03$; $p < .001$, but significantly decreased in the singing condition, $t(27) = 2.67$; $p < .02$. There were also significant differences of means in both mood dimensions, when the two conditions were compared (positive mood: $t(27) = 2.44$; $p < .03$; negative mood: $t(27) = 12.08$; $p < .001$). No significant correlations between physiological and subjective measures were observed.

Condition	Positive Affect	Negative Affect
Singing	0.29 (0.59)	-0.13 (0.26)
Listening	-0.06 (0.69)	0.96 (0.36)

Table 4. Means (and standard deviations) of Positive and Negative Affect score changes in the two experimental conditions.
Note: Scores of each scale were divided by the number of items.

4. DISCUSSION

In this study, we investigated the effects of singing versus listening conditions on specific neurohumoral functions by the measurement of secretory immunoglobulin A (sIgA) and cortisol in healthy amateur singers. Additionally, we also collected subjective psychometric measures of affect. The results show different patterns of effects in the physiological and psychological dependent measures in relation to the experimental conditions.

The main finding with respect to endocrine responses is that singing leads to significant positive increases of mean levels of sIgA, which is considered as the first line of defense against infections in the upper respiratory system. By contrast, listening to choral music did not lead to a significant effect. A different pattern of changes was observed with respect to cortisol. Importantly, significant negative changes of mean cortisol levels were induced by listening, suggesting a general decrease of levels of stress in this condition, whereas no such decrease was observed in the singing condition. Clearly, sIgA and cortisol changes are mediated by different sets of physiological processes as a result of widely differing functions, in which these biochemical parameters are involved. Yet, both seem to be specifically related to physiological arousal.

Some interesting patterns of changes of emotional state emerged. In particular, increases of positive affect, and decreases of negative affect were observed after singing. Informal interviews among the participants corroborate these findings. For example, singing was often found emotionally rewarding, mentally refreshing, or supporting self-awareness in various ways (cf. [2]). Perhaps surprisingly, both significant *increases* of negative mood and significant *decreases* of cortisol were found in response to the listening condition. One possible interpretation of this pattern is that decreases were due to diurnal changes [10], and not directly related to listening to music. At the same time, the fact that a large proportion of the rehearsal time was used without singing may have caused substantial subjective frustration.

A critical point of the present study arises because physical activity in general and singing in particular have not been separated. We consider physical activity as an integrated compound of singing. It is not possible to conceive of singing without physical activity. Therefore, future research should reveal whether the observed effect of singing on sIgA is due to a more general effect of physical activity or whether this effect is specific to solo or group singing respectively.

To sum up, we showed that amateur group singing may lead to significant increases in the production of salivary immunoglobulin A (sIgA), a protein considered as the first line of defense against respiratory infections, as well as to increases of positive affect. This finding confirms and extends previous research addressing benefits of singing to the immune system in birds [6] and humans [2]. Given that every human being is, in principle, capable of developing sufficient vocal skills to participate in a chorale for a lifetime, active group singing may be a risk-free, economic, easily accessible, and yet powerful road to enhance physiological and psychological well-being.

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